

**Soil Cleanup Levels
for
Unrestricted Land Use**

Table 740-1

DEPARTMENT OF ECOLOGY

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TO: Interested Persons
FROM: Pete Kmet, Senior Environmental Engineer
Toxics Cleanup Program
SUBJECT: Calculations for Table 740-1; Method A **Soil** Cleanup Levels
for Unrestricted Land Uses

Attached are several spreadsheets providing background information leading to the Method A soil cleanup levels in Table 740-1. These tables include:

- Table 1: A “**quick summary**” illustrating the current Method A soil cleanup levels, proposed Method A soil cleanup levels, and a brief explanation of the reasoning for the new Method A values. The values that are proposed to be changed are highlighted with boxes.
- Table 2: A **detailed compilation** of the information considered in the development of the Method A soil cleanup levels. This includes: The Method B direct contact values for soil ingestion and soil ingestion plus dermal (skin) absorption (for both carcinogenic effects and noncarcinogenic effects), the Method B soil leaching values using the 100 X ground water rule and the proposed 3 and 4 phase models, the proposed terrestrial ecological evaluation values, values from other laws, the practical quantitation limit, natural background, and other relevant information.
- Table 3: Describes the assumptions and equation used to calculate the Method B values assuming **soil ingestion** (for carcinogens).
- Table 4: Describes the assumptions and equation used to calculate the Method B values assuming **soil ingestion** (for noncarcinogens).
- Table 5: Describes the assumptions and equation used to calculate the Method B values assuming **concurrent soil ingestion plus dermal** (skin) absorption (for carcinogens).
- Table 6: Describes the assumptions and equation used to calculate the Method B values assuming **concurrent soil ingestion plus dermal (skin) absorption** (for noncarcinogens).
- Table 7: Describes the assumptions and equations used to calculate soil concentrations protective of drinking water using the proposed **3 phase leaching model**.
- Tables 8-12 **4-Phase model results** summary sheets for 2 brands of fresh **gasoline** and these same gasolines using various weathered compositions.

Table 1: Quick Summary -- Basis for Method A, Table 740-1, Unrestricted Land Use Soil Values

Hazardous Substance	CAS Number	Current Method A Cleanup Level mg/kg	Proposed Method A Cleanup Level mg/kg	Basis for Standard
Arsenic	7440-38-2	20.0	20	
Benzene	71-43-2	0.5	0.03	Soil ingestion using equation 740-2, and leaching using 3-phase model, adjusted for natural background (1). Protection of drinking water -- based on both 3 and 4 phase models.
Benzo(a)Pyrene	50-32-8	none	0.1	
Cadmium	7440-43-9	2	2	Soil ingestion using equation 740-2. This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8). Protection of drinking water, adjusted for PQL.
Chromium (total)	7440-47-3	100.0	none	Replaced by values for Cr III and Cr VI.
Chromium VI	18540-29-9		19	Protection of drinking water--3 phase model.
Chromium III	16065-83-1		2000	Protection of drinking water--3 phase model.
DDT	50-29-3	1	3	Soil ingestion using equation 740-2.
Ethylbenzene	100-41-4	20.0	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	Protection of drinking water--3 phase model, adjusted for PQL.
Lead	7439-92-1	250.0	250	Soil ingestion. See 1991 responsiveness summary for explanation of calculation. (1)
Lindane	58-89-9	1	0.01	Protection of drinking water--3 phase model, adjusted for PQL.
Methylene chloride	75-09-2	0.5	0.02	Protection of drinking water--3 phase model.
Mercury (inorganic)	7439-97-6	1	2	Protection of drinking water--3 phase model.
MTBE	1634-04-4	none	0.1	Protection of drinking water--3 phase model.
Naphthalenes	91-20-3	none	5	Protection of drinking water--3 phase model. Total of all naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.
PAHs (carcinogenic)		1.0	none	Replaced by Benzo(a)Pyrene, above.
PCB Mixtures	1336-36-3	1	1	ARAR. This is a total value for all PCBs in the soil sample.
Tetrachloroethylene	127-18-4	0.5	0.05	Protection of drinking water--3 phase model.
Toluene	108-88-3	40.0	7	Protection of drinking water--3 phase model.
1,1,1 Trichloroethane	71-55-6	20	2	Protection of drinking water--3 phase model.
Trichloroethylene	79-01-5	0.5	0.03	Protection of drinking water--3 phase model.
Xylenes	1330-20-7	20.0	9	Protection of drinking water--3 phase model. Total of all m, o & p xylene.
TPH (total)	14280-30-9			
Gasoline range organics	6842-59-6			
GRO with benzene		100	30	Protection of drinking water--4 phase model, assuming weathered gasoline composition.
GRO w/o benzene		100	100 (3)	Protection of drinking water--4 phase model, assuming highly weathered gasoline composition.
Diesel Range Organics		200	2000	Protection of drinking water--residual saturation
Heavy Oils		200	2000	Protection of drinking water--residual saturation for diesel.
Electrical Insulating Mineral Oil		200 (2)	4000	Protection of drinking water--residual saturation

(1) Ecology decision not to change at this time. Ecology intends to review and, if appropriate, update these values in a future rulemaking.

(2) Ecology has also issued a fact sheet (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.

(3) To use this value no benzene must be present in the soil and the total of ethyl benzene, toluene & xylene must be less than 1% of the gasoline mixture.

Table 2: Summary Table for Method A Soil Cleanup Values in Table 740-1

Method A Soil Cleanup Levels -for Unrestricted Land Uses										
Hazardous Substance	CAS Number	Current		Dermal +	Dermal +	Leaching	100 X			
		Cleanup Level	Method A	Ingestion	Ingestion	Ingestion	3-Phase	Ground water		
		mg/kg (1)	mg/kg (2)	mg/kg (3)	mg/kg (4)	mg/kg (5)	M odel	C/U level	Vapor	Other
Arsenic	7440-38-2	20.0	0.67	24	0.62	22	2.9	0.5		
Benzene	71-43-2	0.5	34	240	34		0.028	0.5		0.028
Benzo(a)Pyrene	50-32-8	none	0.14		0.10		0.23/1.9 (11)	0.01		
Cadmium	7440-43-9	2.0		80		74	0.69	0.5		
Chromium (total)	7440-47-3	100.0								
Chromium VI	18540-29-9			240		128	19	5		100
Chromium III	16065-83-1			120,000		45,000	2,000	10		
DDT	50-29-3	1.0	2.9	40	2.7	37	4.1	0.03		
Ethylbenzene	100-41-4	20.0		8,000		7,400	6.1	70		
Ethylene dibromide (EDB)	106-93-4	0.001	0.012		0.011		0.00005	0.001		
Lead	7439-92-1	250.0		250/370(10)			3,000	1.5		
Lindane	58-89-9	1.0	0.77	24	0.65	20	0.0062	0.02		
Methylene chloride	75-09-2	0.5	130	4,800	130	4,800	0.022	0.5		
Mercury (inorganic)	7439-97-6	1.0		24		18	2.1	0.2		
MTBE	1634-04-4	none					0.085	2		
Naphthalene	91-20-3	none		1,600		1,200	4.5	16		
PAHs (carcinogenic)(11)		1.0	0.14		0.10		0.23/1.9 (11)	0.01		
PCB Mixtures (12)	1336-36-3	1.0	0.5/2.5/14	1.6/5.6	0.4/1.8/10	1.2/4.1	0.2/1.6	0.01		
Tetrachloroethylene	127-18-4	0.5	20	800	18	740	0.053	0.5		
Toluene	108-88-3	40.0		16,000		15,000	7.3	100		
1,1,1 Trichloroethane	71-55-6	20.0		72,000		72,000	1.6	20		
Trichloroethylene	79-01-5	0.5	91		84		0.033	0.5		
Xylenes	1330-20-7	20.0		160,000		150,000	9.1	100		
(1) From WAC 173-340-740 Table 2 [1/26/96 revision].										
(2) Calculated using equation 740-2.										
(3) Calculated using equation 740-1.										
(4) Calculated using equation 740-5. Except for petroleum mixtures, not used in setting cleanup levels since defaults not changed for other pathways.										
(5) Calculated using equation 740-4. Except for petroleum mixtures, not used in setting cleanup levels since defaults not changed for other pathways.										
(6) Calculated using equation 747-1 and proposed Table 720-1 ground water cleanup levels. Except for Cr III used 100 ppb and for PAHs used Method B value for B(a)P.										
(7) Calculated using 1991 method of 100 X table 720-1 ground water cleanup level. Except for Cr III used 100 ppb.										
(8) Vapor values not calculated.										
(9) Benzene from 4 phase leaching model, assuming part of weathered gasoline mixture; Chromium VI is dust value documented in 1991 MTCA responsiveness summary.										
(10) 1st value using IEUBK model with 200 mg/day soil ingestion rate and is also value documented in 1991 responsiveness summary; 2nd value using IEUBK model with EPA defaults.										
(11) Based on benzo (a) pyrene. First value for 3-phase model results is using the Method B ground water cleanup level, the second value is using the Method A value in proposed Table 720-1.										
(12) PCB values based on various arochloros and IRIS values for PCB mixtures.										

Table 2: Summary Table for Method A Soil Cleanup Values in Table 740-1

Method A Soil Cleanup Levels -for Unrestricted Land Uses								
Hazardous Substance	CAS Number	Cleanup Level	Current	Dermal +	Leaching	100 X	Ground water	Vapor
			Method A	Ingestion	Ingestion			
			mg/kg (1)	mg/kg (2)	mg/kg (3)	mg/kg (4)	mg/kg (5)	mg/kg (6)
TPH (total)	14280-30-9							
Gasoline range organics	6842-59-6	100						
GRO with benzene			4,700	4,700	1 / 23 to 28	1,000	80	unknown
GRO without benzene					105	1,000	100	unknown
Diesel Range Organics		200	3,900	3,000	No upper limit	2,000	50	>10,000
Heavy Oils (8)		200	3,900	3,000	No upper limit	2,000	50	>10,000
Electrical Insulating Mineral Oil		200 (9)	7,800	5,800	No upper limit	4,000	100	Not volatile
(1)	From WAC 173-340-740 Table 2 [1/26/96 revision].							
(2)	Calculated using surrogates. See 1/29/99 Steve Robb memo.							
(3)	Calculated using surrogates and equation 740-4. See 1/29/99 Steve Robb memo.							
(4)	Calculated using 4 phase model. For GRO with benzene, 1st value assumes fresh gas (3% benzene); 2nd values assume weathered gas (~0.1% benzene)							
	For GRO without benzene, assumes no benzene present in gasoline mixture and that ethyl benzene, toluene and xylene are less than 1% of the gasoline mixture.							
	For diesel, heavy oils and mineral oil, "no upper limit" means HI of 1 never exceeded. This is true only if the soil is above the water table.							
(5)	Residual saturation for coarse soils from Coen and Mercer for gas and diesel and BPA study for mineral oil.							
(6)	Calculated using 1991 method of 100 X table 720-1 proposed ground water cleanup level.							
(7)	Gasoline vapors not calculated. The current Method A value of 100 ppm thought to be protective for vapor pathway. Diesel vapors based on qualitative observations at sites by PLIA.							
(8)	Based on diesel composition.							
(9)	Ecology has also issued a fact sheet (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.							

Table 2: Summary Table for Method A Soil Cleanup Values in Table 740-1

Method A Soil Cleanup Levels -for Unrestricted Land Uses										
Hazardous Substance	Ecological Evaluation	Ecological Indicator	Most Stringent Non-Eco Path	Controlling Non-Eco Pathway	ARARs mg/kg	PQL mg/kg (3)	Background mg/kg (4)	Current Method A	Proposed Standard	Basis for Standard
	mg/kg (1)	mg/kg (2)	mg/kg	Pathway				mg/kg	mg/kg	
Arsenic	20	7	0.7	Ingestion		1 (SW7060)	7 & 20	20	20	Natural background. (5)
Benzene			0.03	Leaching		0.005 (SW8260B)		0.5	0.03	Protection of drinking water--4 phase model
Benzo(a)Pyrene	30	12	0.1	Ingestion		0.05 (SW8270C)		none	0.1	Ingestion (7)
Cadmium	25	4	0.69	Leaching		2 (SW6010A)	1	2.0	2	Leaching, adjusted for PQL. (6)
Chromium (total)	42	42				2 (SW6010A)	42	100		
Chromium VI			19	Leaching		1 (SW3060A)			19	Protection of drinking water--3 phase model.
Chromium III			2,000	Leaching		2 (SW6010A)			2000	Protection of drinking water--3 phase model.
DDT	1	0.75	2.9	Ingestion		0.05 (SW8081)		1.0	3	Ingestion.
Ethylbenzene			6.1	Leaching		0.005 (SW8260B)		20	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)			0.00005	Leaching		0.005 (SW8260B)		0.001	0.005	Leaching, adjusted for PQL
Lead	220	50	250	Ingestion		5.0 (SW6010A)	17	250	250	Ingestion (5)
Lindane	10	6	0.0062	Leaching		0.01 (SW8081)		1.0	0.01	Leaching, adjusted for PQL
Methylene chloride			0.022	Leaching		0.005 (SW8260B)		0.5	0.02	Protection of drinking water--3 phase model.
Mercury (inorganic)	9	0.1	2.1	Leaching		0.1 (SW7471)	0.07	1.0	2	Protection of drinking water--3 phase model.
MTBE			0.085	Leaching		0.005 (SW8260B)		none	0.1	Protection of drinking water--3 phase model.
Naphthalenes			4.5	Leaching		0.5 (SW8260B)		none	5	Protection of drinking water--3 phase model. (9)
PAHs (carcinogenic)	30	12	0.1	Ingestion		0.05 (SW8270C)		1.0	none	Replaced with benzo(a)pyrene.
PCB Mixtures	2	0.65	0.2	Leaching	1.0	0.04 (SW8082)		1.0	1	ARAR (8)
Tetrachloroethylene			0.05	Leaching		0.005 (SW8260B)		0.5	0.05	Protection of drinking water--3 phase model.
Toluene		200	7.3	Leaching		0.005 (SW8260B)		40	7	Protection of drinking water--3 phase model.
1,1,1 Trichloroethane			1.6	Leaching		0.005 (SW8260B)		20	2	Protection of drinking water--3 phase model.
Trichloroethylene			0.033	Leaching		0.005 (SW8260B)		0.5	0.03	Protection of drinking water--3 phase model.
Xylenes			9.1	Leaching		0.015 (SW8260B)		20	9	Protection of drinking water--3 phase model.
(1) Value from Table 749-2 for unrestricted land use. For reference only, not used in developing Method A values.										
(2) Most stringent indicator value from Table 749-3. For reference only, not used in developing Method A values.										
(3) From Manchester Lab										
(4) For arsenic, 1st value from upper 90% for WA State, documented in report #94-115 and 2nd value from a 1989 report by PTI Environmental Services. All others upper 90% in WA State from report # 94-115.										
(5) Ecology decision not to change at this time. Ecology intends to review and, if appropriate, update these values in a future rulemaking.										
(6) For cadmium, there are two possible PQLs: 0.1 PPM using SW7131 and 2 PPM using SW6010A. The later has been used since this is the more commonly used test method.										
(7) This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).										
(8) Cleanup level is sum of all PCBs. ARAR is for high occupancy areas with no cap, from 40 CFR Part 761.61 (EPA rule governing disposal and cleanup of PCB contaminated facilities under TSCA).										
(9) This is a total of all naphthalene, 1-Methyl naphthalene & 2-Methyl Naphthalene. Also, use SW 8270C to measure all three types of naphthalene.										

Table 2: Summary Table for Method A Soil Cleanup Values in Table 740-1

Method A Soil Cleanup Levels -for Unrestricted Land Uses										
Hazardous Substance	Ecological	Ecological								
	Simplified Evaluation	Indicator Concentration	Most Stringent Non-Eco Path	Controlling Non-Eco	ARARs	PQL	Background	Current Method A	Proposed Standard	Basis for
	mg/kg (1)	mg/kg (2)	mg/kg	Pathway	mg/kg	mg/kg (3)	mg/kg	mg/kg	mg/kg	Standard
TPH (total)										
Gasoline range organics										
GRO with benzene	200	100	23 to 28	Leaching	5 (NWTPH-Gx)	0	100	30	Protection of drinking water (4)	
GRO without benzene	200	100	105	Leaching	5 (NWTPH-Gx)	0	100	100	Protection of drinking water (5)	
Diesel Range Organics	460	200	2000	Leaching	25 (NWTPH-Dx)	0	200	2000	Residual Saturation	
Heavy Oils (6)	460	200	2000	Leaching	100 (NWTPH-Dx)	0	200	2000	Residual Saturation	
Electrical Insulating Mineral Oil			4000	Leaching	100 (NWTPH-Dx)	0	200 (7)	4000	Residual Saturation	
(1) Value from Table 749-2 for unrestricted land use. For reference only, not used in developing Method A values.										
(2) Most stringent indicator value from Table 749-3. For reference only, not used in developing Method A values.										
(3) From Manchester Lab.										
(4) Based on 4-phase model results for weathered gasoline with 0.1% benzene, a typical value for gasoline contaminated sites.										
(5) Based on 4-phase model results for weathered gasoline assuming no benzene present in soil and that ethyl benzene, toluene & xylene are less than 1% of the gasoline mixture.										
(6) Based on diesel composition.										
(7) Ecology has also issued a fact sheet (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.										

Table 3: Soil Ingestion -- Method B Calculations for Carcinogens

Risk Calculations-Carcinogenic Effects of Soil Ingestion													
Parameter	CAS No.	Risk	Avg. Body	Lifetime	Unit Conv.	Cancer	G.I. Abs.	Soil	Duration	Frequency	Method B	ARAR (3)	Risk @
		(unitless)	(kg)	(years)	(ug/mg)	(kg-day/mg)	Factor	Fraction	Ing. Rate	of Exposure	Carcinogen	ARAR(4)	
Arsenic (5)	7440-38-2	0.000001	16	75	1,000,000	1.5	1.0	200	6	1	0.67		
Benzene	71-43-2	0.000001	16	75	1,000,000	0.029	1.0	200	6	1	34		
Cadmium	7440-43-9					not available							
T Chromium	7440-47-3												
Chromium III	16065-83-1					not available							
Chromium VI	18540-29-9					not available							
DDT	50-29-3	0.000001	16	75	1,000,000	0.34	1.0	200	6	1	2.9		
Ethylbenzene	100-41-4					not available							
Ethylene dibromide (EDB)	106-93-4	0.000001	16	75	1,000,000	85	1.0	200	6	1	0.012		
Lead	7439-92-1					not available							
Lindane	58-89-9	0.000001	16	75	1,000,000	1.3	1.0	200	6	1	0.77		
Methylene chloride	75-09-2	0.000001	16	75	1,000,000	0.0075	1.0	200	6	1	133		
Mercury (inorganic)	7439-97-6					not available							
MTBE	1634-04-4					not available							
Naphthalene	91-20-3					not available							
cPAH Mixtures	na												
Benzo[a]anthracene	56-55-3					not available							
Benzo[b]fluoranthene	205-99-2					not available							
Benzo[k]fluoranthene	207-08-9					not available							
Benzo[a]pyrene	50-32-8	0.000001	16	75	1,000,000	7.3	1.0	200	6	1	0.14		
Chrysene	218-01-9					not available							
Dibenzo[a,h]anthracene	53-70-3					not available							
Indeno[1,2,3-cd]pyrene	207-08-9					not available							
(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for Lindane which is from HEAST.													
(2) Value calculated using equation 740-2 and default assumptions in that equation.													
(3) Applicable, relevant and appropriate requirement.													
(4) ARAR divided by Method B value in column K. Bolded values indicate ARAR exceeds MTCA requirement that risk not exceed 1 X 10-5 [i.e. >10].													
(5) The MTCA CLARC tables currently use a GI absorption fraction of 0.4. That number is no longer thought to be valid and 1.0 is used here.													

Table 3: Soil Ingestion -- Method B Calculations for Carcinogens

Table 4: Soil Ingestion -- Method B Calculations for Noncarcinogens

Risk Calculations--Noncarcinogenic Effects of Soil Ingestion									
Parameter	CAS No.	Reference	Avg. Body	Unit Conv.	Hazard	Soil	G.I. Abs.	Frequency	Method B
		Dose (1)	Weight	Factor	Quotient	Ing. Rate	Fraction	of Contact	Noncarc(2)
		(mg/kg-day)	(kg)	(ug/mg)	(unitless)	(mg/day)	(unitless)	(unitless)	(mg/kg)
Arsenic (5)	7440-38-2	0.0003	16	1,000,000	1	200	1.0	1.0	24
Benzene	71-43-2	0.003	16	1,000,000	1	200	1.0	1.0	240
Cadmium	7440-43-9	0.001	16	1,000,000	1	200	1.0	1.0	80
T Chromium	7440-47-3	not available							
Chromium III	16065-83-1	1.5	16	1,000,000	1	200	1.0	1.0	120,000
Chromium VI	18540-29-9	0.003	16	1,000,000	1	200	1.0	1.0	240
DDT	50-29-3	0.0005	16	1,000,000	1	200	1.0	1.0	40
Ethylbenzene	100-41-4	0.1	16	1,000,000	1	200	1.0	1.0	8,000
Ethylene dibromide (EDB)	106-93-4	not available							
Lead	7439-92-1	not available							
Lindane	58-89-9	0.0003	16	1,000,000	1	200	1.0	1.0	24
Methylene chloride	75-09-2	0.06	16	1,000,000	1	200	1.0	1.0	4,800
Mercury (inorganic)	7439-97-6	0.0003	16	1,000,000	1	200	1.0	1.0	24
MTBE	1634-04-4	not available							
Naphthalene	91-20-3	0.02	16	1,000,000	1	200	1.0	1.0	1,600
cPAH Mixtures	na	not available							
Benzo[a]anthracene	56-55-3	not available							
Benzo[b]fluoranthene	205-99-2	not available							
Benzo[k]fluoranthene	207-08-9	not available							
Benzo[a]pyrene	50-32-8	not available							
Chrysene	218-01-9	not available							
Dibenzo[a,h]anthracene	53-70-3	not available							
Indeno[1,2,3-cd]pyrene	207-08-9	not available							
(1) Source of RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.									
(2) Value calculated using equation 740-1 and default assumptions in that equation.									
(3) Applicable, relevant and appropriate requirement.									
(4) ARAR divided by Method B value in column K. Bolded values indicate ARAR exceeds MTCA requirement that HQ not exceed 1.0.									
(5) The MTCA CLARC tables currently use a GI absorbtion fraction of 0.4. That number is no longer thought to be valid and 1.0 is used here.									

Table 4: Soil Ingestion -- Method B Calculations for Noncarcinogens

Table 5: Method B Calculations for Carcinogens for Soil Ingestion plus Dermal Contact

Risk Calculations--Carcinogenic Effects of Soil Ingestion + Dermal Contact																	
Parameter	CAS No.	Risk	Avg. Body Weight	Averaging Time	Exposure Frequency	Exposure Duration	Soil Ing. Rate	G.I. Abs. Fraction	Oral CPF (1)	Unit Conv. Factor	Surface Area	Adherence Factor	Dermal Abs. Fraction	G.I. Abs. Conv. Factor	Dermal CPF (2)	Method B (3) Carcinogen	
		(unitless)	(kg)	(days)	(days/yr)	(yrs)	(mg/day)	(unitless)	(kg-day/mg)	(ug/mg)	(cm ²)	(mg/cm ² -day)	(unitless)	(unitless)	(kg-day/mg)	(mg/kg)	
	Arsenic	7440-38-2	0.000001	16	27,375	365	6	200	1.0	1.5	1,000,000	2,200	0.2	0.03	0.95	1.6	0.62
Benzene	71-43-2	0.000001	16	27,375	365	6	200	1.0	0.029	1,000,000	2,200	0.2	0.005	0.80	0.036	34	
Cadmium	7440-43-9								not available								
T Chromium	7440-47-3																
Chromium III	16065-83-1								not available								
Chromium VI	18540-29-9								not available								
DDT	50-29-3	0.000001	16	27,375	365	6	200	1.0	0.34	1,000,000	2,200	0.2	0.03	0.70	0.49	2.7	
Ethylbenzene	100-41-4								not available								
Ethylene dibromide (EDB)	106-93-4	0.000001	16	27,375	365	6	200	1.0	85	1,000,000	2,200	0.2	0.03	0.80	106	0.011	
Lead	7439-92-1								not available								
Lindane	58-89-9	0.000001	16	27,375	365	6	200	1.0	1.3	1,000,000	2,200	0.2	0.04	0.50	2.6	0.65	
Methylene chloride	75-09-2	0.000001	16	27,375	365	6	200	1.0	0.0075	1,000,000	2,200	0.2	0.005	0.80	0.0094	133	
Mercury (inorganic)	7439-97-6								not available								
MTBE	1634-04-4								not available								
Naphthalene	91-20-3								not available								
cPAH Mixtures	na																
Benzo[a]anthracene	56-55-3								not available								
Benzo[b]fluoranthene	205-99-2								not available								
Benzo[k]fluoranthene	207-08-9								not available								
Benzo[a]pyrene	50-32-8	0.000001	16	27,375	365	6	200	1.0	7.3	1,000,000	2,200	0.2	0.13	0.89	8.2	0.10	
Chrysene	218-01-9								not available								
Dibenzo[a,h]anthracene	53-70-3								not available								
Indeno[1,2,3-cd]pyrene	207-08-9								not available								
(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for Lindane which is from HEAST.																	
(2) Dermal CPF = Oral CPF / GI abs conversion factor. The GI abs. factor is chemical specific. See equation 740-5 for defaults and 1/25/99 memo for chemical specific factors used here.																	
(3) Calculated using equation 740-5 and default assumptions.																	

Table 5: Method B Calculations for Carcinogens for Soil Ingestion plus Dermal Contact

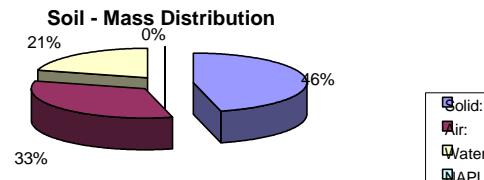
Table 6: Method B Calculations for Noncarcinogens for Soil Ingestion plus Dermal Contact

Table 6: Method B Calculations for Noncarcinogens for Soil Ingestion plus Dermal Contact

Table 7: 3-Phase Modeling Assumptions and Results

Table 8: 4-Phase Model Results using Fresh ARCO Gasoline

Solid:	46.1%
Air:	33.0%
Water:	20.9%
NAPL:	NONE
100.0%	



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics ARCO 1			
EC >5-6	29.93%	0.27	3.49
EC >6-8	15.31%	0.14	1
EC >8-10	3.77%	0.03	0.0
EC >10-12	2.56%	0.02	0.00
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	3.67%	0.033	5.86
Toluene	14.62%	0.13	18
Ethylbenzene	2.73%	0.02	3
Xylenes	13.45%	0.12	13
EC >8-10	4.15%	0.04	1
EC >10-12	7.47%	0.07	1
EC >12-16	0.0191	0.02	0
EC >16-21		0.00	0
EC >21-35		0.00	0
Naphthalene	0.43%	0.00	0
MTBE		0.00	0
Total	100.00%	0.90	47

Total soil porosity: default is 0.43
 Volumetric water content: default is 0.3
 Initial volumetric air content: default is 0.13
 Soil bulk density measured: default is 1.5
 *or, use soil bulk density computed @solid density=2.65kg/l:
 Fraction Organic Carbon: default is 0.001
 Dilution Factor: default is 20

n 0.430 Unitless
 Qw 0.300 Unitless
 Qa 0.130 Unitless
 rb 1.500 kg/l
 1.811 kg/l
 foc 0.0010 Unitless
 DF 20.0 Unitless

Soil Concentration: **0.90**
 Predicted Ground Water TPH (ug/l): **47**
HI @ Predicted G.W. Concentration: 0.27

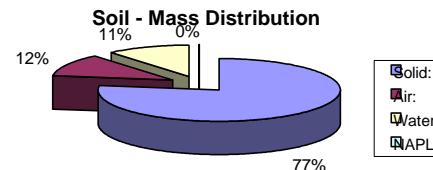
Volumetric NAPL Content, QNAPL : NAPL phase is not existing!
 NAPL Saturation (%), QNAPL/n: N/A
 Type of model used for computation: 3-Phase Model
 Computation completed? Yes!
 TPH Distribution @ 4-phase in soil pore system:
 Total Mass distributed in Water Phase: 20.89% in Solid: 46.11%
 Total Mass distributed in Air Phase: 33.00% in NAPL: NONE

Soil Concentration = 0.90

Gasoline composition from 9/3/98 neat product analysis conducted by Northcreek Analytical, Inc under contract to Ecology.
 This is a summary sheet from an Excel program created by Hun Seak Park at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
 For this particular composition, the allowable soil concentration is controlled by the predicted concentration of benzene (5.86 ug/l) in the ground water.

Table 9: 4-Phase Model Results using ARCO #5 (ARCO composition closest to 0.1% benzene)

Solid:	77.2%
Air:	11.8%
Water:	11.1%
NAPL:	NONE
100.0%	



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics ARCO 5			
EC >5-6	1.36%	0.38	4.93
EC >6-8	13.4%	3.74	22
EC >8-10	12.8%	3.59	4.6
EC >10-12	10.8%	3.02	0.58
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	0.066%	0.019	3.29
Toluene	2.8%	0.80	109
Ethylbenzene	1.8%	0.51	59
Xylenes	10.0%	2.81	308
EC >8-10	11.6%	3.26	89
EC >10-12	26.3%	7.35	135
EC >12-16	7.7%	2.16	21
EC >16-21		0.00	0
EC >21-35		0.00	0
Naphthalene	1.27%	0.35	17
MTBE		0.00	0
Total	100.00%	28.00	774

Total soil porosity: default is 0.43
Volumetric water content: default is 0.3
Initial volumetric air content: default is 0.13
Soil bulk density measured: default is 1.5
*or, use soil bulk density computed @solid density=2.65kg/l:
Fraction Organic Carbon: default is 0.001
Dilution Factor: default is 20

n 0.430 Unitless
Qw 0.300 Unitless
Qa 0.130 Unitless
rb 1.500 kg/l
1.811 kg/l
foc 0.0010 Unitless
DF 20.0 Unitless

Soil Concentration: 28.00
Predicted Ground Water TPH (ug/l): 774
HI @ Predicted G.W. Concentration: 1.01

Volumetric NAPL Content, QNAPL : NAPL phase is not existing!
NAPL Saturation (%), QNAPL/n: N/A
Type of model used for computation: 3-Phase Model
Computation completed? Yes!
TPH Distribution @ 4-phase in soil pore system:
Total Mass distributed in Water Phase: 11.05% in Solid: 77.18%
Total Mass distributed in Air Phase: 11.76% in NAPL: NONE

Soil Concentration = 28.00

Gasoline composition is fresh product weathered to approximately 0.1% benzene, simulated by removal of mass in dissolved and vapor phases by successive model runs.

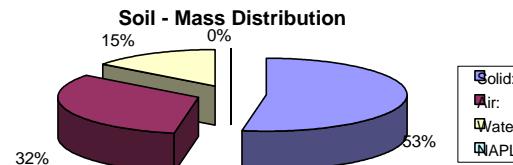
This benzene composition is typical of soil benzene concentrations found in soils at gasoline contaminated sites in WA State.

This is a summary sheet from an Excel program created by Hun Seak Park at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.

For this particular composition, the allowable soil concentration is controlled by the predicted hazard index of the gasoline mixture in the ground water.

Table 10: 4-Phase Model Results using Fresh BP Gasoline

Solid:	52.9%
Air:	32.4%
Water:	14.8%
NAPL:	NONE
100.0%	



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics Fresh BP			
EC >5-6	28.48%	0.28	3.69
EC >6-8	17.2%	0.17	1
EC >8-10	4.6%	0.05	0.1
EC >10-12	5.5%	0.06	0.01
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	2.9%	0.029	5.16
Toluene	7.7%	0.08	11
Ethylbenzene	1.7%	0.02	2
Xylenes	8.9%	0.09	10
EC >8-10	5.5%	0.06	2
EC >10-12	9.2%	0.09	2
EC >12-16	6.6%	0.07	1
EC >16-21	0.0%	0.00	0
EC >21-35	0.0%	0.00	0
Naphthalene	1.6%	0.02	1
MTBE	0.0%	0.00	0
Total	100.0%	1.00	37

Total soil porosity: default is 0.43
Volumetric water content: default is 0.3
Initial volumetric air content: default is 0.13
Soil bulk density measured: default is 1.5
*or, use soil bulk density computed @solid density=2.65kg/l:
Fraction Organic Carbon: default is 0.001
Dilution Factor: default is 20

Soil Concentration: **1.00**

Predicted Ground Water TPH (ug/l): **37**

HI @ Predicted G.W. Concentration: 0.24

Volumetric NAPL Content, QNAPL : NAPL phase is not existing!
NAPL Saturation (%), QNAPL/n: N/A
Type of model used for computation: 3-Phase Model
Computation completed? Yes!

TPH Distribution @ 4-phase in soil pore system:

Total Mass distributed in Water Phase: 14.75% in Solid: 52.87%

Total Mass distributed in Air Phase: 32.38% in NAPL: NONE

Soil Concentration = 1.00

Gasoline composition from 9/3/98 neat product analysis conducted by Northcreek Analytical, Inc under contract to Ecology.
This is a summary sheet from an Excel program created by Hun Seak Park at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
For this particular composition, the allowable soil concentration is controlled by the predicted concentration of benzene (5.16 ug/l) in the ground water.

Table 11: 4-Phase Model Results for BP#4 (BP Composition closest to 0.1% Benzene)



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	BP #4		
EC >5-6	2.640%	0.58	7.53
EC >6-8	14.131%	3.11	18
EC >8-10	9.935%	2.19	2.8
EC >10-12	13.808%	3.04	0.58
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	0.127%	0.028	4.95
Toluene	2.003%	0.44	61
Ethylbenzene	1.135%	0.25	29
Xylenes	6.427%	1.41	155
EC >8-10	10.248%	2.25	62
EC >10-12	20.242%	4.45	82
EC >12-16	16.106%	3.54	34
EC >16-21	0.000%	0.00	0
EC >21-35	0.000%	0.00	0
Naphthalene	3.198%	0.70	34
MTBE	0.000%	0.00	0
Total	100.000%	22.00	490

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5 *or, use soil bulk density computed @solid density=2.65kg/l:	rb	1.500	kg/l
Fraction Organic Carbon: default is 0.001	foc	1.811	kg/l
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration: **22.00**

Predicted Ground Water TPH (ug/l): 490

HI @ Predicted G.W. Concentration: 0.92

Volumetric NAPL Content, QNAPL :	NAPL phase is not existing!
NAPL Saturation (%), QNAPL/n:	N/A
Type of model used for computation:	3-Phase Model
Computation completed?	Yes!
TPH Distribution @ 4-phase in soil pore system:	

Total Mass distributed in Water Phase: 8.90% in Solid: 78.72%
Total Mass distributed in Air Phase: 12.37% in NAPL: NONE

Soil Concentration = 22.00

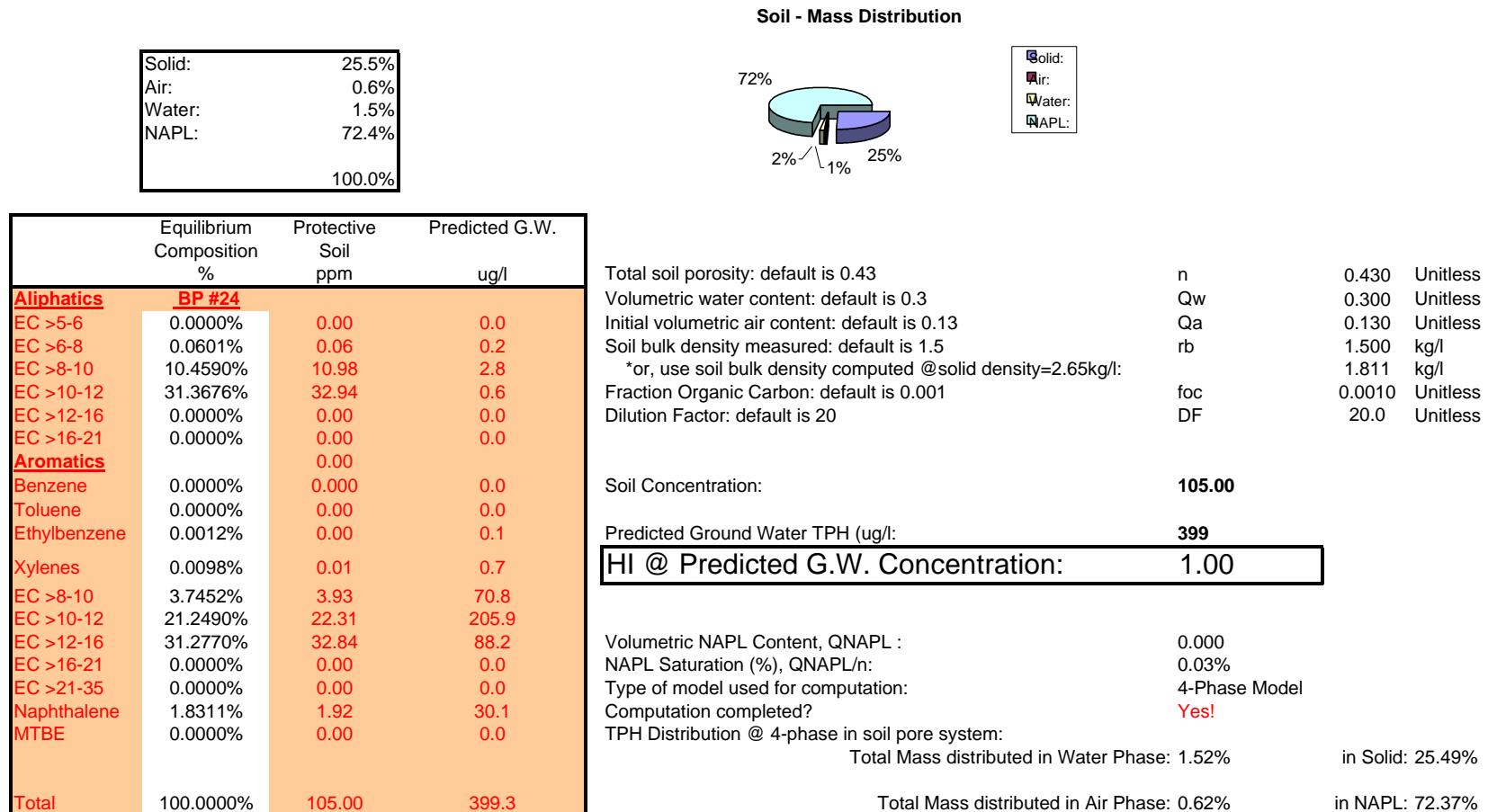
Gasoline composition is fresh product weathered to approximately 0.1% benzene, simulated by removal of mass in dissolved and vapor phases by successive model runs.

This benzene composition is typical of soil benzene concentrations found in soils at gasoline contaminated sites in WA State.

This is a summary sheet from an Excel program created by Hun Seak Park at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.

For this particular composition, the allowable soil concentration is controlled by the predicted concentration of benzene (4.95 ug/l) in the ground water.

Table 12: 4-Phase Model Results for BP #24 (least weathered composition with HI<1 at 100 PPM in the Soil)



Soil Concentration = 105.00

Gasoline composition is fresh product weathered until 100 PPM in the soil will pass, simulated by removal of mass in dissolved and vapor phases by successive model runs.

This composition represents highly weathered gasoline with no detectable benzene in the soil.

This is a summary sheet from an Excel program created by Hun Seak Park at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.

For this particular composition, the allowable soil concentration is controlled by the predicted hazard index of the gasoline mixture in the ground water.